FLUID LINE CONNECTOR ASSEMBLY

[0001] This application claims priority from U.S. Provisional Patent Application No. 60/457,530 filed on March 25 2003, which is hereby incorporated herein by reference in its entirety.

Background of the Invention

[0002] This invention relates to the art of fluid line connector assemblies and, more particularly, to thin-walled, flexible fluid line connector assemblies for use in low-pressure applications.

[0003] Thin-walled, flexible fluid line connector assemblies have been provided heretofore and generally include a length of thin-walled, corrugated, flexible tubing having opposing non-corrugated tubing ends, a flare nut retained on each tubing end and a flare fitting cooperable with each flare nut to form a fluid-tight seal between the flare fitting, the tubing end and the flare nut. The tubing ends commonly include a generally cylindrical journal portion and a radially outwardly extending flare portion. The flare nuts are retained on the non-corrugated tubing ends by the flare portion, which is deformed radially outwardly after assembly with the flare nut to engage the same and thereby prevent removal thereof from the end of the length of tubing. To form the fluid-tight seal with the flexible tubing, a flare fitting is threadably engaged into each of the flare nuts. The flare fitting includes a frustoconical-leading surface that compressively engages the flare portion of the tubing end. As the flare fitting and flare nut are threadably tightened together, the frustoconical leading surface of the flare fitting displaces the flare portion of the flexible tubing against an interior surface of the flare nut. This displacement causes the flare portion of the tubing to be compressively engaged between the flare fitting and flare nut and causes a metal-to-metal seal to form between the tubing, the flare fitting and the flare nut such that the assembly becomes fluid tight.

[0004] A disadvantage of connector assemblies of the foregoing nature is that tightening the flare nut and flare fitting together to form the metal-to-metal seal with the flexible tubing causes the flare fitting, flare nut and flexible tubing to become rotatably fixed relative to one another. As such, the flare fitting and flare nut are not able to rotate relative to the thin-walled, flexible tubing. As a result, the connector assembly can be difficult to install, especially in areas having limited clearance and

access. Additionally, the flexible tubing can become torsionally stressed during the installation of the connector assembly, which it is desirable to avoid where possible.

Brief Summary of the Invention

[0005] In accordance with the present invention, a fluid line connector assembly is provided that avoids or minimizes the problems and difficulties encountered in connection with connector assemblies of the foregoing nature while promoting an increase in performance and reliability, and maintaining a desired simplicity of structure, economy of manufacture and ease of installation.

[0006] More particularly in this respect, a fluid line connector assembly is provided and includes a length of flexible tubing having a tubing end. A first fitting body is received on the tubing end. A second fitting body is secured to the first fitting body. At least one of the first fitting body and the second fitting body forms a fluid-tight connection with the tubing end. A third fitting body is rotatably supported on the second fitting body. A sealing member forms a fluid-tight seal between the second fitting body and the third fitting body.

[0007] Another fluid line connector assembly is provided that includes a length of flexible tubing having a tubing end. A first fitting body is received on the tubing end. A second fitting body is rotatably supported on the first fitting body, and a sealing member forms a fluid-tight seal between the tubing end and one of the first fitting body and the second fitting body.

[0008] A further fluid line connector assembly is provided that includes a length of flexible tubing having a tubing end. A first fitting body is received on the tubing end. A second fitting body is secured to the first fitting body. At least one of the first fitting body and the second fitting body at least partially forms a compression seal along the tubing end. A third fitting body is rotatably supported on the second fitting body. A sealing member forms a fluid-tight seal between the second fitting body and the third fitting body.

[0009] Still another fluid line connector assembly is provided that includes a length of flexible tubing having a tubing end. A first fitting body is received on the tubing end. A second fitting body is secured to the first fitting body. A compression ring is captured on the tubing end between the first and second fitting bodies. The compression ring at least partially forms a compression seal along the tubing end. A third fitting body is rotatably supported on the second fitting body. A sealing

member forms a fluid-tight seal between the second fitting body and the third fitting body.

[0010] A method of assembling a fluid line connector assembly is provided and includes the steps of: providing a length of flexible tubing having a tubing end, a first fitting body, a second fitting body having an inwardly extending groove, a third fitting body having an outwardly extending groove, a sealing member, and a retaining member; positioning the first fitting body on the tubing end; securing the second fitting body on the first fitting body and forming a fluid-tight seal between one of the first and second fitting bodies and the tubing end; positioning the sealing member on the second fitting body and the retaining member within at least a portion of the inwardly extending groove; positioning the third fitting body on the second fitting body such that the retaining member is received within at least a portion of the outwardly extending groove and the sealing member is compressively positioned between the second and third fitting bodies.

Brief Description of the Drawings

[0011] FIGURE 1 is a cross-sectional view of a conventional connector assembly shown partly assembled.

[0012] FIGURE 2 is a cross-sectional view of the conventional assembly of FIGURE 1 shown fully assembled.

[0012] FIGURE 3 is a partial cross-sectional view of a fluid line connector assembly in accordance with the present invention.

[0013] FIGURE 4 is a partial cross-sectional view of one end of the fluid line connector assembly of FIGURE 3.

[0014] FIGURE 5 is a partial cross-sectional view of an alternate embodiment of a fluid line connector assembly in accordance with the present invention.

[0015] FIGURE 6 is a partial cross-sectional view of one end of the fluid line connector assembly of FIGURE 5.

[0013] FIGURE 7 is a partial cross-sectional view of one end of another embodiment of a fluid line connector assembly in accordance with the present invention.

[0014] FIGURE 8 is a partial cross-sectional view of one end of still another embodiment of a fluid line connector assembly in accordance with the present invention.

[0015] FIGURE 9 is a partial cross-sectional view of one end of still another embodiment of a fluid line connector assembly in accordance with the present invention.

[0016] FIGURE 10 is a partial cross-sectional view of one end of yet another embodiment of a fluid line connector assembly in accordance with the present invention.

[0017] FIGURE 11 is a partial cross-sectional view of one end of a further embodiment of a fluid line connector assembly in accordance with the present invention.

[0018] FIGURE 12 is a partial cross-sectional view of one end of still a further embodiment of a fluid line connector assembly in accordance with the present invention.

[0019] FIGURE 13 is a partial cross-sectional view of one end of still a further embodiment of a fluid line connector assembly in accordance with the present invention.

[0020] FIGURE 14 is a partial cross-sectional view of one end of yet a further embodiment of a fluid line connector assembly in accordance with the present invention.

[0021] FIGURE 15 is a partial cross-sectional view of an end fitting assembly in accordance with the present invention.

[0022] FIGURE 16 is a partial cross-sectional view of another embodiment of one end of a fluid line connector assembly in accordance with the present invention.

Detailed Description of the Invention

[0023] It will be appreciated that FIGURES 1 and 2 respectively illustrate a conventional fluid line connector assembly for connection between a transmission line and an appliance, such as a gas supply line and a gas stove. Such fluid line connector assemblies are generally known to those skilled in the art, and the following discussion of FIGURES 1 and 2 is merely provided to establish background, environment and terminology for further discussion of the preferred embodiments of the present invention.

[0024] FIGURE 1 illustrates a conventional fluid line assembly **10** that includes a length of thin-walled, flexible tubing **20**, a flare nut **40** and a flare fitting **60**. The length of tubing **20** has two opposing ends **22**, only one of which is shown in

FIGURES 1 and 2. The tubing end **22** terminates at a tubing edge **24** and includes a journal portion **26** and a flare portion **28**. The length of thin-walled, flexible tubing **20** has a plurality of helically extending tubing corrugations **30** and is formed from metal, typically stainless steel.

[0025] The flare nut **40** is retained on tubing **20** at tubing end **22** by flare portion **28**. The flare nut has a threaded end **42** and a strain-relief end **44**. A journal passage **46** extends through flare nut **40** and is cooperable with journal portion **26** of tubing end **22** such that the flare nut is freely rotatable about a central access **CL** of assembly **10** as shown by arrows **A**. Extending toward threaded end **42** from journal passage **46** is flare seating surface **48**, which extends radially outwardly from the journal passage in a frustoconical manner. Female fitting threads **50** extend inwardly from threaded end **42** toward flare seating surface **48**. The female fitting threads are generally coaxial with the journal passage **46**. Opposite female fitting threads **50** at strain-relief end **44** is an axially-extending annular recess **52** that extends from the strain-relief end toward the threaded end and is adapted to receive at least a portion of one or more corrugations **30**. Assembly **10** also includes a braided sheath **32** that extends axially along the length of the flexible tubing between the tubing ends. Sheath **32** is commonly formed from metallic wire. An inner collar **34** is received on journal portion **26** of tubing end **22**, and at least a portion of the braided sheath extends along the exterior of the inner collar. A braid retaining collar **36** is crimped or otherwise deformed against the inner collar to retain the braided sheath therebetween. Wrench flats **54** are provided along at least a portion of the exterior of flare nut **40**. Additionally, flare portion **28** of tubing end **22** extends radially outwardly from journal portion **26** adjacent flare seating surface **48** of flare nut **40**. As indicated by arrow **A**, in the disassembled condition, flexible tubing **20** and flare nut **40** are rotatable relative to one another.

[0026] Flare fitting **60** is shown in FIGURE 1 disassembled from tubing **20** and flare nut **40**. The flare fitting has a fitting end **62** and a connection end **68**. The fitting end has male fitting threads **64** adjacent a frustoconical, flare-engaging surface **66**. The connection end includes connection threads **70**. Positioned between the fitting end and the connection end of flare fitting **60** are wrench flats **72**. A fluid passage **74** extends centrally through the flare fitting.

[0027] FIGURE 2 shows male fitting thread **64** of flare fitting **60** engaged with female fitting threads **50** of flare nut **40**. As flare fitting **60** is threadably rotated into

flare nut **40**, flare-engaging surface **66** of the flare fitting advances toward flare portion **28** of flexible tubing **20**. Ultimately, flare-engaging surface **66** contacts flare portion **28**, which is thereby forced against flare seating surface **48** of flare nut **40** effecting metal-to-metal contact between the three components. Once such contact has been made, further rotation of the flare fitting into the flare nut causes a metal-to-metal seal to form between flare-engaging surface **66**, flare portion **28** of the flexible tubing, and flare seating surface **48** of the flare nut. This metal-to-metal seal is suitable for forming a fluid-tight passage through connector assembly **10**. It will be appreciated, however, that this same metal-to-metal contact between the three components prevents rotation of these components relative to one another. As such, it will be appreciated that the entire connector assembly **10** must be rotated to threadably engage connector threads **70** into a fluid transmission line or appliance (not shown), for example.

[0028] Referring in greater detail to FIGURES 3-6, wherein the showings are for the purposes of illustrating preferred embodiments of the invention only, and not for the purpose of limiting the invention. FIGURES 3 and 4 illustrate a fluid line connector assembly **100** that includes a length of thin-walled flexible tubing **110** with opposing ends **112**, a flare nut **120**, and a swivel fitting assembly **140** retained on each of the tubing ends. Tubing ends **112** are non-corrugated and generally cylindrical and include a journal portion **114** and a flare portion **116**. Tubing corrugations **118** extend helically along the length of flexible tubing between tubing ends **112**. Additionally, the length of flexible tubing defines a central axis **AX**.

[0029] As can be better seen in FIGURE 4, flare nut **120** includes a threaded end **122** and a strain-relief end **124** opposite the threaded end. Extending generally centrally through the flare nut is a journal passage **126** which is cooperable with journal portion **114** of the tubing end **112** such that the flare nut is received on the tubing end and can rotate relative thereto. An annular recess **128** extends into the flare nut from strain-relief end **124**. Flare nut **120** is oriented on the tubing end such that annular recess **128** receives at least a portion of one or more helical corrugations **118**. A plurality of female threads **130** extend inwardly from threaded end **122** opposite strain-relief end **124**. A flare seating surface **132** extends radially outwardly in a frustoconical manner from journal passage **126** toward female threads **130**. The flare seating surface is adapted to cooperate with flare portion **116** of tubing end **112**. Wrench flats **134** are disposed along the exterior of flare nut

120 between the threaded and strain-relief ends.

[0030] Swivel fitting assembly **140** includes a base fitting **141** that has a tube-engaging end **142** and a connection end **144**. A passage **146** extends generally centrally through the base fitting between the opposing ends thereof. The tube-engaging end includes a plurality of male threads **148** that threadably engage female threads **130** of flare nut **120**. A flare-engaging surface **150** extends from the tube-engaging end toward the male threads. Opposite the tube-engaging end at connection end **144**, a generally cylindrical shoulder portion **152** is provided inwardly of the connection end. A retaining ring groove **154** extends radially inwardly along shoulder portion **152**. A sealing portion **156** is provided axially outwardly of shoulder portion **152**. A plurality of wrench flats **158** extend along the outside of base fitting **141** for the tightening thereof into flare nut **120**.

[0031] Threaded end cap **160** has a passage **162** extending therethrough. The passage includes a bearing surface **164**, a sealing surface **166** and a plurality of female threads **168**. A plurality of male threads **170** extend along the exterior of the threaded end cap, and wrench flats **172** are provided for torsionally rotating the threaded end cap to connect to a fluid transmission line or appliance. Bearing surface **164** is cooperable with shoulder portion **152** of the base fitting such that the threaded end cap will rotate relative thereto, as indicated by arrows **RO**. A retaining ring groove **174** extends radially outwardly from bearing surface **164**. Threaded end cap **160** is supported on base fitting **140** such that retaining ring grooves **154** and **174** are axially aligned radially opposite one another for each to receive at least a portion of a retaining ring **180**, that axially retains the threaded end cap on the base fitting while allowing the threaded end cap to remain freely rotatable relative thereto, again as indicated by arrows **RO**. A sealing member, such as o-ring **182**, for example, is compressively positioned between the sealing portion of the base fitting and the sealing surface of the threaded end cap to form a fluid-tight seal therebetween.

[0032] FIGURES 5 and 6 illustrate a fluid line connector assembly **200** that is substantially identical to connector assembly **100** discussed hereinbefore. However, connector assembly **200** further includes a braided sheath **290** and a coating layer **292** disposed along the exterior of the tubing. An inner collar **294** is supported on journal portion **214** axially inwardly of flare nut **220**. At least a portion of braided sheath **290** extends along the exterior of each inner collar **294** and a braid retaining

collar **296** is positioned radially outwardly of each inner collar and crimped or otherwise deflected radially inwardly to secure the end of the braided sheath therebetween. Additionally, coating layer **292** may be provided along the exterior of the braided sheath and portions of the flare nut to provide improved cleanability and other benefits as may be desired in certain applications. The coating layer is formed from a flexible plastic material, preferably plasticized polyvinylchloride. However, a variety of other suitable flexible materials can be used, such as polyethylene or synthetic rubber, for example. It should be appreciated, however, that the coating layer is optional in the embodiment illustrated in FIGURES 5 and 6.

[0033] In assembling a fluid line connector assembly **100** in accordance with the present invention, a length of flexible tubing **110** that has a pair of opposing tubing ends **112** that are generally cylindrical and non-corrugated, as discussed above, is first provided. Next, one or more flare nuts **120** are provided and installed on at least one of the tubing ends. Each tubing end that has received a flare nut is then flared radially outwardly, which prevents the axial removal of the flare nut from each end. Thereafter, a swivel fitting assembly **140** is provided that includes a base fitting **141**, a threaded end cap **160**, a retaining ring **180** and one or more sealing members **182**. Preferably, the swivel fitting assembly will be pre-assembled, and the base fitting will then be threaded into the flare nut to form a metal-to-metal seal between the base fitting, the flare portion of the tubing end and the flare nut. Where the swivel fitting assembly is not pre-assembled, the sealing member and retaining ring are preferably installed into the threaded end cap in the appropriate positions. The threaded end cap is then axially displaced onto the base fitting until the retaining ring engages the groove in the base fitting and retains the threaded end cap thereon. At which point, the sealing member will preferably be compressively positioned between the base fitting and the threaded end cap.

[0034] It will be appreciated that the foregoing discussion of a method of assembling a fluid line connector is equally applicable to other embodiments of fluid line connectors in accordance with the present invention including, but not limited to, connector assembly **200**. It will be further appreciated that, in certain configurations, some of the foregoing steps can be modified or omitted or other steps added without departing from the principles of the present invention. One such alternate method of assembly of a fluid line connector assembly **200** is substantially identical to that discussed above with regard to connector assembly **100**, except that a braided

sheath **290** that extends about the exterior of the tubing and along its length is provided and installed prior to the installation of the flare nuts, as discussed above. In such case, the braided sheath is preferably secured to the tubing at each tubing end by a suitable method, such as by crimping or otherwise radially inwardly deforming a braid retaining collar **296** about a portion of the braided sheath, for example. Thereafter, the provided flare nuts are installed and assembly proceeds as discussed above.

[0035] Additionally, other end fitting assemblies can be used to construct fluid line connector assemblies in accordance with the present invention. Such connector assemblies can optionally include a braided sheath and/or a coating layer as discussed in detail hereinbefore, though such features are not shown in and/or described with regard to FIGURES 7-16. It will be appreciated that the various end fitting configurations shown in and described with regard to FIGURES 7-16 provide a fluid-tight end fitting on a length of flexible tubing and that the end fitting includes a rotatable or swivel portion supported thereon.

[0036] FIGURE 7 illustrates a fluid line connector assembly **300** that includes a length of thin-walled flexible tubing **302** having a tubing end **304**. The tubing end includes a generally cylindrical journal portion **306** and a radially outwardly extending flared portion **308** positioned along tubing end **304** outward of journal portion **306**. An end fitting assembly **310** is supported on tubing end **304** and includes an outer flare ring **312**, an inner flare fitting **314**, and a swivel fitting **316** that is rotatably supported on inner flare fitting **314**. Outer flare ring **312** includes a generally cylindrical journal passage **318** extending therethrough and is received on journal portion **306** of tubing end **304**. Frustoconical wall portion **320** extends radially outwardly from journal passage **318** to a generally cylindrical wall portion **322**.

[0037] Inner flare fitting **314** includes a fluid passage **324** extending therethrough in fluid communication with flexible tubing **302**. A frustoconical wall portion **326** is provided along the exterior of inner flare fitting **314** and extends radially outwardly to a generally cylindrical wall portion **328**. It will be appreciated that frustoconical wall portions **320** and **326**, respectively of outer flare ring **312** and inner flare fitting **314**, extend radially outwardly at angles complementary with one another and suitable for forming a fluid-tight seal with flared portion **308** of tubing end **304**. Frustoconical wall portions **320** and **326** are shown in FIGURE 7 as having substantially identical

included angles (not numbered). However, it will be appreciated that other suitable angles can be used and that the two wall portions can have different included angles without departing from the principles of the present invention. For example, the included angle (not numbered) of frustoconical wall portion **320** can be about one-half degree to about six degrees smaller than an included angle (not numbered) of frustoconical wall portion **326** such that when inner flare fitting **314** is displaced toward outer flare ring **312**, the two frustoconical wall portions **320** and **326** form a metal-to-metal seal with flared portion **308** of tubing end **304**.

[0038] A generally cylindrical support wall **330** extends axially from wall portion **328** and is shown in FIGURE 7 as having an outside diameter that is less than the outside diameter of wall portion **328**. A radially inwardly extending retaining ring groove **332** is provided along support wall **330**. Two sealing member grooves **334** are also provided therealong and extend radially inwardly from support wall **330**. Sealing member grooves **334** are dimensioned to receive and axially retain any suitable sealing member, such as an o-ring **336**.

[0039] Swivel fitting **316** includes an inner wall **338** suitable dimensioned for being rotatably received on support wall **330** of inner flare fitting **314**. Sealing members, such as o-rings **336**, form a fluid-tight seal between inner wall **338** of swivel fitting **316** and grooves **334** in support wall **330**. A radially outwardly extending retaining ring groove **340** is provided along inner wall **338** and axially aligned radially opposite groove **332** in support wall **330** for receiving a suitable retaining ring **342**, which engages at least a portion of each of grooves **332** and **340** to axially retain swivel fitting **316** on inner flare fitting **314**. Wrench flats **344** are provided along the exterior of swivel fitting **316** and are suitable for rotating the same such that male threads **346** can be suitably engaged with a mating part (not shown), such as a female connector. It will be appreciated, however, that other configurations of the swivel fitting may alternatively or additionally include female threads of any suitable type or form.

[0040] FIGURE 8 illustrates a fluid line connector assembly **300'** that is substantially similar to connector assembly **300** shown and described with regard to FIGURE 7. As such, like features will be shown and described with like item numbers, and new or modified features or elements will be primed ('). Any features or elements shown and described in one figure, but having no counterpart in the other figure, will be distinctly pointed out and described where appropriate.

[0041] Fluid line connector assembly **300'** includes a length of thin-walled flexible tubing **302** having a tubing end **304'** with a generally cylindrical journal portion **306** and a radially outwardly extending flange portion **308'**. An end fitting assembly **310'** is supported on tubing end **304'** and includes a flange ring **312'**, a flange fitting **314'** and a swivel fitting **316**. In FIGURE 8, flanged portion **308'** extends radially outwardly in a direction generally transverse to journal portion **306**. As such, frustoconical wall portions **320** and **326** shown in FIGURE 7 are not provided. Rather, flanged portion **308'** is compressively positioned between end wall **322'** of flange ring **312'** and end wall **328'** of flange fitting **314'**. It will be appreciated that end wall **328'** of flange fitting **314'** is formed by an annular recess **329'** extending axially into flange fitting **314'** such that flanged portion **308'** of tubing end **304'** is received therein. It will be appreciated, however, that such an annular recess can be additionally or alternately provided in end wall **322'** of flange ring **312'**.

[0042] Fluid line connector assemblies **300** and **300'**, shown respectively in FIGURES 7 and 8, will be assembled in a substantially identical manner. As such, the following discussion of such assembly will refer to the features and item numbers shown in FIGURE 7, but it will be appreciated that such assembly steps will be equally applicable to the assembly shown and described with regard to FIGURE 8.

[0043] Initially, a length of flexible tubing **302** is provided having a tubing end **304** with a generally cylindrical journal portion **306** formed thereon. Outer flare ring **312** is fitted onto the journal portion and radially outwardly extending flare portion **308** is then formed thereon capturing flare ring **312** on tubing end **304**. Inner flare fitting **314** is thereafter fitted into flared portion **308** of tubing end **304** and the two components are pressed together compressing flared portion **308** of tubing end **304** to form a fluid-tight, metal-to-metal seal between flare ring **312**, flared portion **308** and flare fitting **314**. While retained in the pressed-together relationship, flare ring **312** and flare fitting **314** are joined together by any suitable method, such as staking, pinning, brazing, tack welding or all-around welding, for example, forming a joint **348** (or **348'** in FIGURE 8). It will be appreciated that the fluid-tight seal between the flare ring and the flare fitting is formed by the metal-to-metal contact with flared portion **308** and not by the joint between the flare ring and the flare fitting. Once flare ring **312** and flare fitting **314** have been suitably joined together, swivel fitting **316** can be assembled onto flare fitting **314** and retained thereon by retaining

ring **342** with sealing members, such as o-rings **336** compressively positioned between the swivel fitting and the flare fitting to form a fluid-tight seal therebetween.

[0044] FIGURES 9-11 illustrate another embodiment of a fluid line connector assembly in accordance with the present invention. FIGURE 9 illustrates a fluid line connector assembly **400** that includes a length of thin-walled flexible tubing **402** and an end fitting assembly **410** supported on a tubing end **404** of tubing **402**. The tubing end has a generally cylindrical journal portion **406** and a radially outwardly extending flared portion **408**. End fitting assembly **410** supported on tubing end **404** includes an outer flare ring **412** and a swivel fitting **414**. Outer flare ring **412** has a generally cylindrical outer wall **416** and an inner wall **418** having a frustoconical wall portion **420** and a cylindrical wall portion **422**. A radially outwardly extending retaining ring groove **424** is provided along cylindrical wall portion **422** of outer flare ring **412**. It will be appreciated that flare ring **412** is retained on tubing end **404** by flared portion **408** thereof, and that frustoconical wall portion **420** is suitable for receiving flared portion **408** adjacent thereto.

[0045] Swivel fitting **414** has a flare-engaging end **426** and a threaded end **428** opposite flare-engaging end **426**. A fluid passage **430** extends through swivel fitting **414** between ends **426** and **428**. Threaded end **428** includes a plurality of male threads **432**. However, it will be appreciated that female threads can alternately and/or additionally be provided, and that any such threads can be of any suitable type or form. Wrench flats **434** are provided on swivel fitting **414** between flare-engaging end **426** and threaded end **428**. The flare-engaging end includes an outside wall **436** having a generally cylindrical wall portion **438** and a frustoconical wall portion **440** that extends from cylindrical wall portion **438** to fitting edge **442**. A radially inwardly extending retaining ring groove **444** is provided in swivel fitting **414** along cylindrical wall portion **438**. Retaining ring groove **444** is axially aligned radially opposite retaining ring groove **424** in flare ring **412**, and a retaining ring **446** is at least partially received in each of grooves **424** and **444** to axially retain swivel fitting **414** on outer flare ring **412**. Frustoconical wall portion **440** includes a seal groove **448** for receiving a sealing member, such as an o-ring **450**, for example. Flared portion **408** of tubing end **404** is captured between frustoconical wall portions **420** and **440**. O-ring **450** is compressively positioned between flared portion **408** of tubing end **404** and seal groove **448** of swivel fitting **414** forming a fluid-tight seal along the tubing end while remaining rotatable relative thereto.

[0046] Fluid line connector assembly **400'** is substantially similar to connector assembly **400** shown in and discussed with regard to FIGURE 9. As such, like features will be identified by and discussed using like item numbers, and new or modified features or elements will be identified by and discussed using primed (') item numbers.

[0047] Fluid line connector assembly **400'** includes a length of thin-walled flexible tubing **402** and an end fitting assembly **410'** supported on tubing end **404**, as discussed with regard to FIGURE 9. End fitting assembly **410'** includes an outer flare ring **412** and a swivel fitting **414'** that has a flare-engaging end **426'** and a threaded end **428**. An outside wall **436'** extends along flare-engaging end **426'** and includes a generally cylindrical wall portion **438**, a frustoconical wall portion **440**, and an extension wall portion **452'** extending between frustoconical wall portion **440** and a fitting edge **442'**. Extension wall portion **452'** is dimensioned to fit into journal portion **406** of tubing end **404**. The extension wall portion includes a seal groove **454'** suitable for receiving a sealing member, such as a gasket **456'**, for example, and capturing the sealing member between journal portion **406** of tubing end **404** and the seal groove. As such, swivel fitting **414'** remains freely rotatable relative to tubing end **404**, while forming a fluid-tight seal therewith.

[0048] FIGURE 11 illustrates a fluid line connector assembly **500** that is substantially similar to that is shown in and described with regard to FIGURE 9. Unless otherwise indicated, the features in FIGURE 11 correspond to those illustrated in and discussed with respect to FIGURE 9. However, the features in FIGURE 11 include reference numerals incremented by 100. Features shown and described in one drawing figure, but having no counterpart in the other figure, will be distinctly pointed out and discussed where appropriate.

[0049] Fluid line connector assembly **500** includes a length of thin-walled flexible tubing **502** and an end fitting assembly **510** supported on a tubing end **504**. The tubing end has a generally cylindrical journal portion **506** and a radially outwardly extending flange portion **508** formed axially outwardly from journal portion **506** on tubing end **504**. End fitting assembly **510** includes an outer flange ring **512** and a swivel fitting **514**. Flange ring **512** is retained on tubing end **504** by flange portion **508**. Flange ring **512** includes an outer wall **516** and in inner wall **518** that has a frustoconical wall portion **520** and a generally cylindrical wall portion **522**. An end wall **523** is provided adjacent frustoconical wall portion **520** opposite and extending

generally transverse to cylindrical wall portion **522**. The outside diameter of flange portion **508** of tubing end **504** is preferably dimensioned to be received on and engage end wall **523**. Swivel fitting **514** includes a flange-engaging end **526** and a threaded end **528** opposite the flange-engaging end. The flange-engaging end has an outside wall **536** that includes a generally cylindrical wall portion **538** and a frustoconical wall portion **540** that extends radially inwardly from wall portion **538** to a fitting edge **542**. Retaining ring grooves **524** and **544** extend respectively outwardly and inwardly into flare ring **512** and swivel fitting **514**. At least a portion of a retaining ring **546** is at least partially received in each of grooves **524** and **544** to retain flare ring **512** and swivel fitting **514** in axial relation to one another. A seal groove **548** is provided along fitting edge **542** and is suitable for receiving a sealing member, such as an o-ring **550**, for example. It will be appreciated that flange portion **508** is captured between end wall **523** and fitting edge **542** and that o-ring **550** is compressively positioned between flange portion **508** and seal groove **548** to form a fluid-tight seal therewith. As such, swivel fitting **514** forms a fluid-tight connection with tubing **502** while remaining rotatable relative thereto.

[0050] Still another embodiment of a fluid line connector assembly in accordance with the present invention is shown in FIGURES 12-14. Fluid line connector assembly **600** shown in FIGURE 12 includes a length of thin-walled flexible tubing **602** and an end fitting assembly **604** supported on a generally cylindrical tubing end **606** adjacent tubing edge **608** of tubing **602**.

[0051] End fitting assembly **604** includes a connector fitting arrangement **610** having a first connector component **612** and a second connector component **614**. The end fitting assembly also includes a swivel fitting **616** rotatably supported on connector component **614** of fitting arrangement **610**. First connector component **612** has an inside bore **618** that extends between first component ends **620** and **622**. Inside bore **618** fits onto tubing end **606** such that limited clearance is provided therebetween. The exterior of first connector component **612** includes a cylindrical portion **624** adjacent component end **620** and a plurality of male threads **626** adjacent the cylindrical portion extending toward component end **622**. Wrench flats **625** are provided along cylindrical portion **624**. A frustoconical wall portion **628** extends from adjacent male threads **626** along component end **622**.

[0052] Second connector component **614** has a fluid passage **630** extending therealong between component ends **632** and **634**. A plurality of female threads

636 extends into connector component **614** from component end **632** along fluid passage **630**. A shoulder **638** is provided within fluid passage **630** inwardly adjacent threads **636**. Shoulder **638** extends generally transverse fluid passage **630** and is suitably dimensioned to receive tubing end **606** of tubing **602**. A compression wall **640** extends between female threads **636** and shoulder **638**. Preferably, compression wall **640** is suitably adapted to engage frustoconical wall portion **628** of connector component **612** and radially inwardly displace the same as components **612** and **614** threadably engage one another by way of threads **626** and **636**, respectively. In addition to forming a radially inwardly acting compression fit between end **622** of connector component **612** and tubing end **606**, connector components **612** and **614** preferably threadably engage one another such that frustoconical wall portion **628** sufficiently contacts compression wall **640** to form a fluid-tight, metal-to-metal seal therebetween.

[0053] Wrench flats **642** are provided along the exterior of connector component **614**. Adjacent the wrench flats along the exterior of connector component **614** are cylindrical wall portions **644** and **646** and a frustoconical wall portion **648** extending therebetween. A radially inwardly extending retaining ring groove **650** is provided on cylindrical wall portion **644**, and a radially inwardly extending sealing groove **652** is provided on cylindrical wall portion **646** adjacent frustoconical wall portion **648**.

[0054] Swivel fitting **616** has wrench flats **654** extending along the exterior thereof. Additionally, a plurality of male threads **656** are provided along the exterior of swivel fitting **616** adjacent wrench flats **654**. A fluid passage **658** extends through swivel fitting **616**. Cylindrical inside wall portions **660** and **662** extend along fluid passage **658**, and a frustoconical inside wall portion **664** extends therebetween. Wall portions **660**, **662** and **664** of swivel fitting **616** are complementary to wall portions **644**, **646** and **648** such that swivel fitting **616** is rotatably supported on connector component **614**. A radially outwardly extending retaining ring groove **668** is provided on wall portion **660**, and at least a portion of retaining ring **670** is received in each of retaining ring grooves **650** and **668** to axially retain swivel fitting **616** on connector component **614**.

[0055] Fluid line connector assembly **600'** shown in FIGURE 13 is substantially identical to connector assembly **600** shown in and discussed with regard to FIGURE 12. As such, like elements and features will be identified by and discussed using like item numbers, and new or modified features and elements will be shown by and

discussed using primed (') item numbers. Features shown in and discussed with regard to one drawing, but having no counterpart in the other, will be distinctly pointed out and discussed where appropriate.

[0056] Fluid line connector assembly **600'** includes a length of thin-walled flexible tubing **602** and an end fitting assembly **604'**. The end fitting assembly includes a connector fitting arrangement **610'** and a swivel fitting **616**. Connector fitting arrangement **610'** includes a first connector component **612'** and a second connector component **614'**. Connector component **612'** includes a plurality of female threads **636'** and inside bore **638'** with a compression wall **640'** extending therebetween. Component **612'** is positioned on tubing end **606** such that female threads **636'** extend outwardly from tubing end **606**. Connector component **614'** includes an inside bore **618'** extending along a fluid passage **630'**. A plurality of male threads **626'** extends along the exterior of connector component **614'** to a frustoconical wall portion **628'**. Inside bore **618** slips over tubing end **606** of tubing **602**, and a shoulder **619'** abuts tubing edge **608** of tubing end **606**. Accordingly, as connector components **612'** and **614'** threadably engage one another, compression wall **640'** of connector component **612'** radially inwardly displaces frustoconical wall portion **628'** compressively engaging tubing end **606** and retaining end fitting assembly **604'** thereon. The resulting compressive fit between frustoconical end **628'** and tubing end **606** form a fluid-tight seal therebetween. Furthermore, frustoconical end **628'** and compression wall **640'** sufficiently contact one another to form a metal-to-metal seal therebetween. Swivel fitting **616** is rotatably supported on component **614'** as discussed hereinbefore with regard to component **614**.

[0057] FIGURE 14 illustrates a fluid line connector assembly **600''** that is substantially similar to fluid line connector assembly **600'** shown in and described with regard to FIGURE 13. As such, like features will be identified by and described using like item numbers, and new or modified features and elements will be shown by and described using double primed (") item numbers. Features shown in and described with regard to one drawing figure, but having no counterpart in the other drawing figure, will be distinctly pointed out and discussed where appropriate.

[0058] Fluid line connector assembly **600''** includes an end fitting assembly **604''** supported on a generally cylindrical tubing end **606** of a length of thin-walled flexible tubing **602**. End fitting assembly **604''** includes a connector fitting arrangement **610''** and a swivel fitting **616**. Connector fitting arrangement **610''** includes first

connector component **612'** and second connector component **614''** as well as a compression ring **672''**. It will be appreciated that connector component **614''** does not include a feature similar to frustoconical wall portion **628'** shown in FIGURE 13. Rather, in place of such a feature, connector component **614''** includes a compression wall **674''** that is substantially similar to compression wall **640'** on connector component **612'**. Compression ring **672''** includes two oppositely extending frustoconical external wall portions **676''**, and a generally cylindrical inside wall having an inside diameter dimensioned such that the compression ring slips onto tubing end **606**. As connector components **612'** and **614''** are threadably engaged toward one another, the respective compression walls thereof engage frustoconical external wall portions **676''** of compression ring **672''** and radially inwardly displace the same forming a compressive seal between the compression ring and tubing end **606**. As such, end fitting assembly **604''** is retained on tubing **602** thereby. It will be appreciated that compression ring **672''** can be formed from any suitable material including both metals and polymer materials, for example.

[0059] FIGURE 15 illustrates an end fitting assembly **700** for use in association with a suitable fluid line connector, such as connector assembly **100** shown in FIGURES 3 and 4. In such an arrangement, end fitting assembly **700** is preferably used in place of swivel fitting assembly **140**. End fitting assembly **700** includes a connector fitting **702** and a swivel fitting **704** rotatably supported on connector fitting **702**. The connector fitting has a connection end **706** and a swivel end **708**. A fluid passage **710** extends through connector fitting **702** between ends **706** and **708**. The exterior of connector fitting **702** includes a frustoconical wall portion **712** and a plurality of male threads **714** adjacent wall portion **712**. Cylindrical wall portions **716**, **718** and **720** extend along the exterior of connector fitting **702** adjacent swivel end **708**. A shoulder **722** extends between wall portions **716** and **718**, and one or more frustoconical wall portions extend between cylindrical wall portions **718** and **720**. Cylindrical wall portion **718** includes a radially inwardly extending retaining ring groove **726**. A plurality of wrench flats **717** can optionally be provided on cylindrical wall portion **716**.

[0060] Extending along the exterior of swivel fitting **704** are wrench flats **728** and a plurality of male threads **730**. A fluid passage **732** extends through swivel fitting **704** and is suitably dimensioned to cooperate with fluid passage **710** extending through connector fitting **702**. Inside cylindrical wall portions **734**, **736** and **738**

extend along fluid passage **732**. A shoulder **740** suitable for cooperating with shoulder **722** of connector fitting **702** extends between cylindrical wall portions **734** and **736** of swivel fitting **704**. A frustoconical wall portion **742** extends between cylindrical wall portions **736** and **738**. Cylindrical wall portion **738** extends from frustoconical wall portion **742** to an end wall **744** extending generally transverse fluid passage **732**. Cylindrical wall portion **736** includes a radially outwardly extending retaining ring groove **746** that is axially aligned radially opposite retaining ring groove **726** of connector fitting **702**. A retaining ring **748** is at least partially received within each of grooves **726** and **746** to axially retain swivel fitting **704** on connector fitting **702**. One or more sealing members, such as o-rings **750**, are compressively positioned between cylindrical wall portion **720** of connector fitting **702** and cylindrical wall portion **738** of swivel fitting **704**. The o-rings are axially retained by end wall **744** of swivel fitting **704** and by frustoconical wall portion **724** of connector fitting **702**. A spacer ring **752** can be included where two or more sealing members, such as o-rings **750**, are used.

[0061] Installation and/or assembly of end fitting assembly **700** includes threadably engaging connector fitting **702** into a suitable mating flare nut, such as flare nut **120** of connector assembly **100**, for example, such that frustoconical wall portion **712** engages a flare portion, such as flare portion **116**, for example, of an associated tubing end, such as tubing end **112**, for example. As connector fitting **702** and the associated flare nut are threadably advanced toward one another, frustoconical wall portion **712** engages the flare portion of the tubing end and forms a metal-to-metal seal therewith. It will be appreciated that wrench flats **717** or other suitable features provided along cylindrical wall portion **716** of connector fitting **702** can be used to tighten connector fitting **702** and the associated flare nut together to ensure the metal-to-metal seal with the flared portion of the tubing end. As swivel fitting **704** is thereafter installed on connector fitting **702**, cylindrical wall portion **734** preferably advances the over the wrench flats of connector fitting **702** and cover the same such that the wrench flats are unavailable for further engagement.

[0062] Still a further fluid line connector assembly **800** in accordance with the present invention is shown in FIGURE 16. The connector assembly includes a length of thin-walled flexible tubing **802** and an end fitting assembly **804**. Tubing **802** includes a plurality of corrugations **806** extending therealong. It will be appreciated that corrugations **806** can be of any suitable form and configuration,

such as helical or annular corrugations, for example. End fitting assembly **804** includes a connector fitting arrangement **808** and a swivel fitting **810** rotatably supported thereon.

[0063] Connector fitting arrangement **808** includes connector ring **812**, connector nut **814** and connector post **816**. Connector ring **812** has a generally cylindrical outside wall **818** and an inside wall **820** having a plurality of corrugations **822** and a frustoconical wall portion **824**. It will be appreciated that corrugations **822** suitably cooperate with and engage corrugations **806** of flexible tubing **802**. Connector ring **812** also has end walls **826** and **828** extending generally transverse outside wall **818**. It will be appreciated that connector ring **812** is a split ring allowing the same to be spread apart at the split (not shown) to extend over and engage corrugations **806** of flexible tubing **802**.

[0064] Connector nut **814** has a generally cylindrical outside wall **830** extending between opposing end walls **832** and **834**. An inside wall **836** extends through the connector nut and has an intermediate wall portion **837** extending radially outward to a generally cylindrical wall portion **838** that includes a plurality of female threads **840** adjacent end wall **834**. It will be appreciated that cylindrical wall portion **838** is dimensioned to receive outside wall **818** of connector ring **812**, and that connector nut **814** engages connector ring **812** such that walls **837** and **826** are in abutting engagement with one another. It will be further appreciated that connector nut **814** is fitted onto tubing **802** prior to the assembly of connector ring **812** onto the tubing end interengaging corregations **806**.

[0065] Connector post **816** has a fluid passage **844** extending therethrough. The exterior of connector post **816** includes a frustoconical wall portion **846** provided at one end thereof, a plurality of male threads **848** adjacent the frustoconical wall portion, and a generally cylindrical wall portion **850**. Threads **848** of connector post **816** threadably engage threads **840** of connector nut **814**. As the connector nut and connector post are threaded together, frustoconical wall portion **846** is advanced toward frustoconical wall portion **824** of connector ring **812** forming compressed corrugations **806A** therebetween, which forms a fluid-tight seal between corrugations **806A** and frustoconical wall portion **846** of the connector post. Cylindrical wall portion **850** of connector post **816** includes a radially inwardly extending retaining ring groove **852** and one or more radially inwardly extending sealing grooves **854**.

[0066] Swivel fitting **810** is rotatably supported on connector post **816** of fitting arrangement **808**. The swivel fitting has a fluid passage **856** extending therethrough formed by an inside wall **858**. A radially outwardly extending retaining ring groove **860** extends into swivel fitting **810** from inside wall **858** and is positioned therealong adjacent retaining ring groove **852** on connector post **816**. A retaining ring **862** is at least partially received in each of retaining ring grooves **852** and **860** to axially retain swivel fitting **810** on connector post **816** of fitting arrangement **808**. A counter bore extends axially into swivel fitting **810** from adjacent connector nut **814** forming a shoulder **864** and an axially extending annular ring **866** that is suitably dimensioned to extend over outside wall **830** of the connector nut. Wrench flats **868** are provided along the exterior of swivel fitting **810** and a plurality of male threads **870** are provided adjacent the wrench flats.

[0067] While the invention has been described with reference to the preferred embodiments and considerable emphasis has been placed herein on the structures and structural interrelationships between the component parts of the embodiments disclosed, it will be appreciated that other embodiments of the invention can be made and that many changes can be made in the embodiments illustrated and described without departing from the principles of the invention. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. For example, the flared portion of the tubing ends are shown as being flared at an included angle of about 60 degrees in certain embodiment, such as those shown in FIGURES 9 and 10, for example; or at an included angle of about 90 degrees in other embodiments, such as those shown in FIGURES 3-7, for example; or at an included angle of about 180 degrees in other embodiments, such as those shown in FIGURE 8, for example. As such, an included angle of from about none or 0 degrees (in the case of a non-flared end) to an angle of about 180 degrees or more can be used. Accordingly, it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the present invention and not as a limitation. As such, it is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of this disclosure.